Coastal Engineering Technical Note

REVETMENT FAILURE - AN AUSTRALIAN LESSON

PURPOSE: This Technical Note abstracts the field observations by Smith and Chapman (1982) on the response of coastal revetment structures under extreme storm conditions on the Gold Coast of Australia. Discussions are focused on the observed mode of structure failure and the significance of toe protection design to overall structure stability.

MODE of FAILURE: The typical revetment configuration at the Gold Coast consists of a double layer of large boulders as the armor units, a secondary layer, and a filter layer of well weathered quarry overburden as illustrated by Figure 1. All boulder revetments are founded at Mean Sea Level. The 20-km revetment constructed for beach erosion protection suffered various degree of damages during the three extreme storms in 1972, 1974, and 1976. Total structure failure occurred at a length of 0.8 km (1.3 miles).

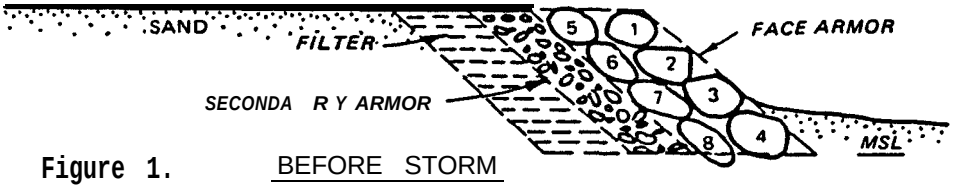

Figure 1. BEFORE STORM

As reported by Smith and Chapman (1982), the initial failure was always triggered by subsidence of the toe units, thus causing the first armor layer to rattle down the slope (see Figure 2). As the freeboard is reduced, waves overtop the revetment and erode the filter material (see Figure 3). Finally, the wall collapses landward into the eroded space (Figure 4) and is buried beneath the beach profile (Figure 5). The observed failure sequence occurs in less than 20 minutes for revetments over 5 m (16 ft) high.

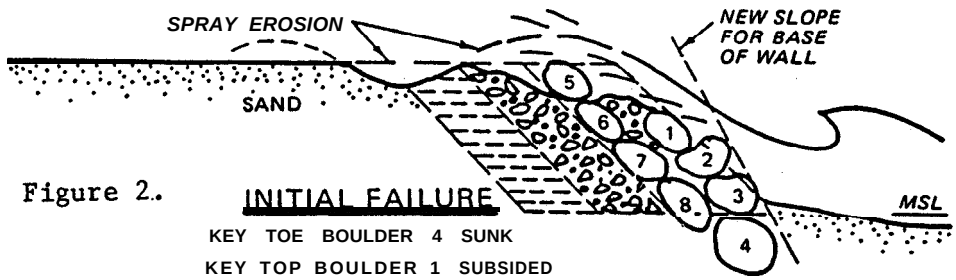

Figure 2.

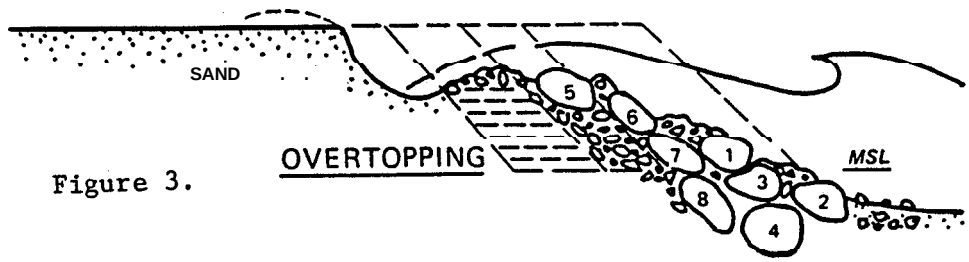

Figure 3.

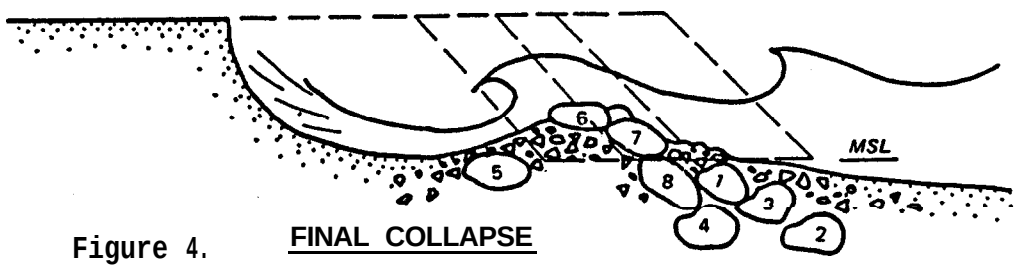

Figure 4.

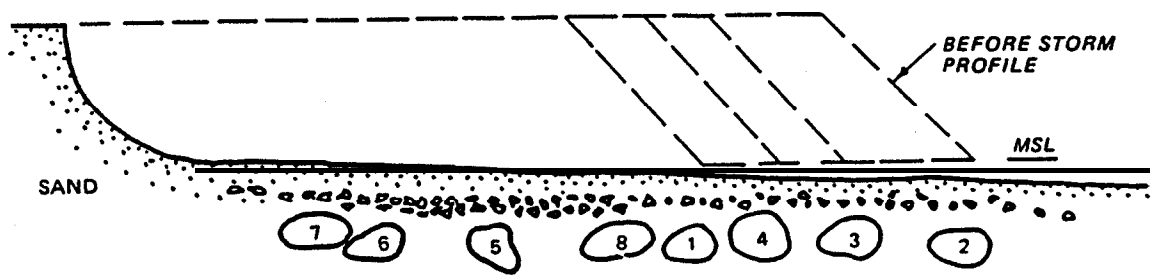

Figure 5. AFTER STORM

GROUTED REVETMENTS: Smith and Chapman also reported that grouting the armor units by filling the voids with concrete has not enhanced the structure stability. On the contrary, grouted revetment reduces the permeability thus, increases magnitudes of wave runup and overtopping that lead to extensive early soil erosion at the back of revetment. This erosion initiates toe scour which causes settlement of the toe units, and leaves the mass of grouted armor units in suspension. The grouted revetment collapses eventually in a single shattering event.

TOP AND TOE PROTECTIONS: It was observed that the stability of top and toe units are critical to overall structural integrity. Dislocation of these armor units would result in structure failure. The initiation of toe failure is always followed by "beach fluidization" at toe area when the wave trough passes there. Large toe units, particularly with low specific surface, easily sink into the fluidized beach. It is recommended that proper design should be accomplished by extending the toe units deep into a stable layer inside the beach profile. The design guidance for rubble toe protection, provided in EM 1110-Z-1614 (U.S. Army Corps of Engineers, 1985) and in Chapter 7 of the SPM (1984), should be followed to minimize the chance of toe failure,

The top armor unit has no gravity surcharge and has the least interlocking with its neighboring units. Therefore, it is the unit most susceptible to wave uprush and backwash actions. Dislocation of the top units could result in back erosion which further lead to toe scouring. Smith and Chapman (1982) recommend the use of the largest high aspect armor units laid flat at the top of'the revetment with their smallest face exposed seaward.

ADDITIONAL INFORMATION: For additional information contact Dr. Yen-hsi Chu at (601) 634-2067 of the Coastal Engineering Research Center.

REFERENCE:

Smith, A. W., and Chapman, D. M. 1982. "The Behavior of Prototype Boulder Revetment Walls", Proceedings of 18th Coastal Engineering Conference, Cape Town, South Africa.

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